PRE-RULEMAKING WORKSHOP

Draft Proposal for Residential Walls

2016 Building Energy Efficiency Standards

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Proposed Code Change Overview

Residential Walls

- Prescriptive U-factor ~0.05 for exterior walls
  - CZs 1-6 and 8-16
  - Applies to low-rise residential buildings

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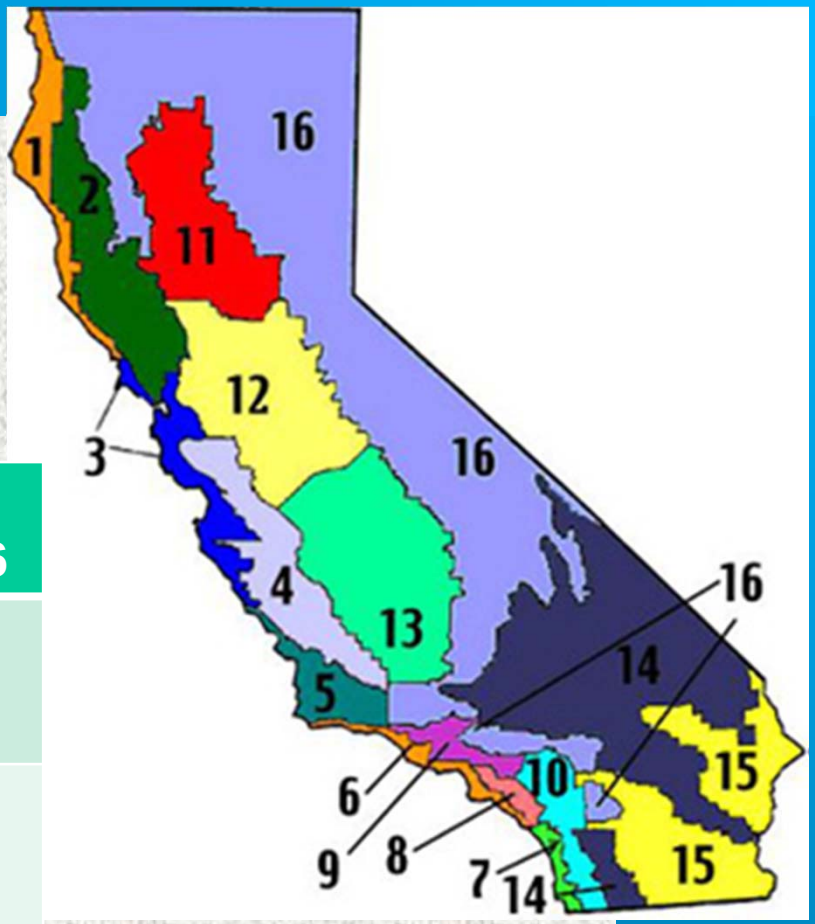
Current Code Requirements



Effective Code	CA CZ 2-10	CA CZ 11-13	CA CZ 1, 14-16
2008 Prescriptive	R-13	R-19	R-21
2013 Prescriptive	**Maximum U-factor: 0.065 (R-15+4 or R-13+5)**		
2013 Compliance Option (Performance)	SIPs, ICFs, AWF, or other wall assemblies (i.e., 2x6 @ 24” o.c. etc.)		

Note: These climate zones are California specific.

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Methodology for Savings Analysis

Energy and Life Cycle Costs

- CBECC-Res energy simulation
- Analysis using 2013 TDV (will update with 2016 TDV when available)
- Prototype buildings
  - Res: 2,700 SF (2-story) and 2,100 SF (1-story)

    55/45 weighting for applicability of prototypes statewide
- Baseline:
  - Minimally compliant with 2013 Prescriptive Requirements

    (U: 0.065 aka 2x4" studs w/ R15 cavity + R4 continuous insulation, no QII)

Incremental Cost Scenarios

2013 Prescriptive Baseline

Stud	Cavity	Exterior	U-factor	Incremental Cost	IMC /s.f. wall area	Cavity Insulation Type
2x4	R15	R4 (1")	0.065	-	-	High density batt
2x6	R21	R4 (1")	0.051	$463	$0.26	Loose-fill cellulose or high density batt
2x4	R15	R8 (2")	0.050	$622	$0.35	High density batt
2x6	R23	R4 (1")	0.049	$507	$0.29	High density batt or mineral wool
2x6	R19	R6 (1.25")	0.049	$477	$0.27	Low density fiberglass batt
2x6	R23	R5 (1")	0.047	$887	$0.50	High density batt or mineral wool
2x6	R21	R6 (1.25")	0.046	$783	$0.44	Loose-fill cellulose or high density batt
2x4	R15	R10 (2")	0.045	$989	$0.56	High density batt
2x6	R23	R6 (1.25")	0.044	$827	$0.47	High density batt or mineral wool

These scenarios all assume 16” O.C. framing

- Increasing spacing from 16” to 24” o.c. can save ~$0.10/sf of wall area based on lumber cost savings and optimal wood use

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Cost Basis (average installed cost)

Product Type	R-Value	Description	$/ ft²	ft²/ home	$/ home
Concrete Stucco	-	Stucco, 3 coats, float finish, with mesh, on wood frame, 1" thick	$4.89	1268	$6,200
	-	One-Coat Stucco (RS MEANS)	$3.86		$4,896
Batt Insulation	13	Fiberglass, foil faced and unfaced, 3.5"	$0.70	1268	$883
	15	Blanket, Mineral wool, 3.5"	$0.98		$1,244
	19	Fiberglass kraft faced, foil faced, and unfaced, 6"	$0.79		$998
	21	Fiberglass unfaced batt insulation, 6"	$1.03		$1,304
	23	Blanket, Mineral wool, 5.5"	$1.06		$1,349
Rigid Insulation	4	EPS, and molded bead board	$0.83	1268	$1,050
	5	XPS, EPS, Polyiso and molded bead board	$1.13		$1,429
	6	EPS, Polyiso	$1.02		$1,300
	8	EPS, and molded bead board	$1.21		$1,538
	10	XPS, Polyiso	$1.50		$1,904
Spray foam	R4/in	Open cell spray foam ~R22 in 2x6 frame, cost per board foot	$0.38	6,975	$2,616
	R7/in	Closed cell spray foam ~R24 in 2x4 frame, cost per board foot	$1.00	4,439	$6,975
Loose fill	21	Poured insulation, cellulose fiber, R3.8 per inch, 6" thick	$0.90	1268	$1,143
Gypsum board	-	Standard and fire resistant	$0.74	1268	$938
OSB	-	7/16", 1/2", 5/8"	$1.30	1774	$2,312
Weather Barrier	-	Asphalt felt, polypropylene, and polyethylene	$0.25	1774	$447
Wood Framing	-	2x4 16"OC	$1.01	1774	$1,793
	-	2x6 16"OC	$1.13		$2,005
	-	2x6 24"OC	$0.99		$1,765
Metal Flashing	-	Sheet Metal Cladding, aluminum, window casing, up to 6 bends, .024" thick	$4.84	118	$571

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Present Value Energy Savings Scenarios

Framing	2x6@16oc					2x6@16	2x4@16		2x6@24
Exterior Insulation	R4		R6			R8	R8	R10	R6
Cavity Insulation	R21	R23	R19	R21	R23	R19	R15		R21
Incremental Cost	$463	$507	$477	$783	$827	$779	$622	$989	$594
U-factor	0.051	0.049	0.049	0.046	0.044	0.043	0.050	0.045	0.045
CZ 1	$1,080	$1,264	$1,315	**$1,497**	$1,655	$1,670	$1,115	$1,490	$1,550
CZ 2	$827	$964	$1,005	**$1,137**	$1,255	$1,265	$830	$1,110	$1,168
CZ 3	$597	$696	$729	**$825**	$912	$922	$614	$816	$848
CZ 4	$757	$877	$909	**$1,028**	$1,131	$1,139	$743	$988	$1,044
CZ 5	$585	$680	$705	**$796**	$873	$882	$589	$777	$820
CZ 6	$418	$478	$495	**$557**	$613	$618	$398	$527	$563
CZ 7	$202	$229	$238	**$261**	$286	$289	$187	$245	$263
CZ 8	$484	$561	$572	**$642**	$707	$699	$440	$584	$639
CZ 9	$772	$896	$917	**$1,037**	$1,144	$1,135	$720	$959	$1,033
CZ 10	$848	$985	$1,004	**$1,143**	$1,260	$1,247	$806	$1,073	$1,143
CZ 11	$1,484	$1,734	$1,782	**$2,026**	$2,238	$2,234	$1,467	$1,949	$2,052
CZ 12	$1,221	$1,422	$1,475	**$1,668**	$1,839	$1,846	$1,194	$1,590	$1,688
CZ 13	$1,486	$1,734	$1,786	**$2,025**	$2,241	$2,237	$1,456	$1,942	$2,049
CZ 14	$1,415	$1,657	$1,699	**$1,929**	$2,135	$2,131	$1,394	$1,859	$1,957
CZ 15	$1,676	$1,847	$1,929	**$2,260**	$2,475	$2,481	$1,554	$2,166	$2,278
CZ 16	$1,424	$1,665	$1,740	**$1,972**	$2,178	$2,196	$1,452	$1,931	$2,026

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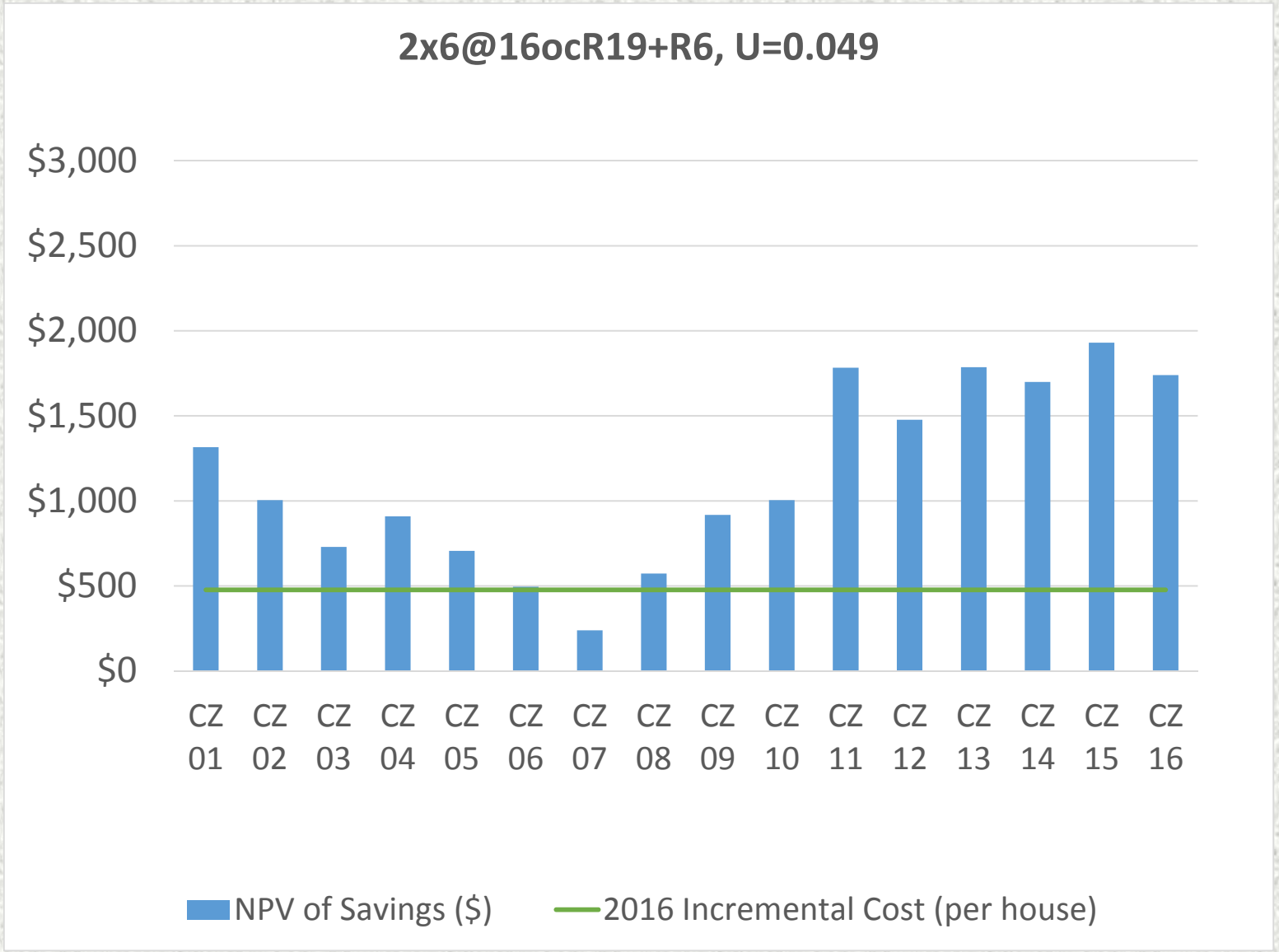
Preliminary Energy Savings, U-factor = 0.049



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Proposed Prescriptive Standard

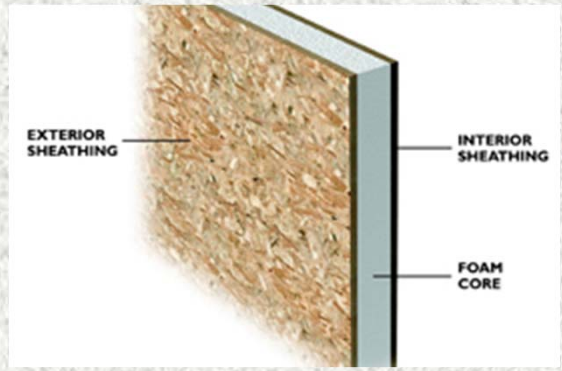
U-factor of 0.05

- Climate Zones **1-6 and 8-16**, all but San Diego coast (CZ 7)
- Cost effective using
  - 2x6 @ 16”OC, R19 + R6 (.048)
- Many other wood frame options:
  - 2x4 @ 16”OC, R15 + R8 (.05)
  - 2x6 @ 16” OC, R21 + R5 (.048)
  - 2x6 AWF R19 + R4 (.05)

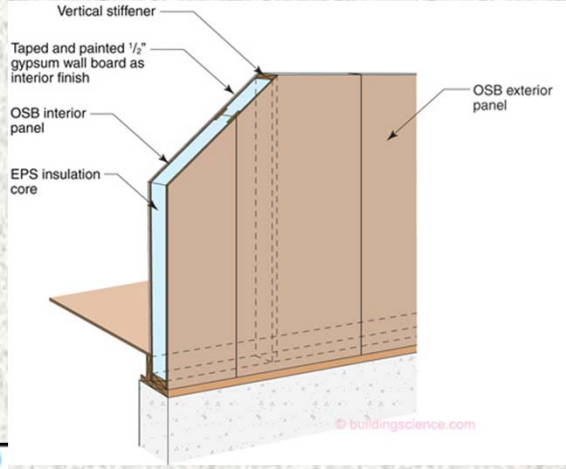
Alternative Compliance Options

Strategy	Description
SIPs	Pre-fabricated Structural Insulated Panels.
ICFs	Pre-fabricated Insulated Concrete Forms
Advanced Framing	2x6” studs at 24” O.C. framing, 2-stud corners, insulated headers, etc., minimizes thermal bridging and allows for greater volume of cavity insulation.
Staggered Studs	Two 2x4” studded walls staggered to minimize thermal bridging and allow for greater volume of cavity insulation.
Double Wall	Two 2x4” studded walls allow for greater volume of cavity insulation.
Increased Rigid External Insulation	Adding >1.25” of external insulation can achieve lower U-factors and reduce the impact of thermal bridging.

Compliance Option - SIPs



Source: www.sips.org



Source: Building Science Corporation (2004)

Table 4.3.2 – U-factors of Structurally Insulated Wall Panels (SIPS)

Wood Framing Connection Type (spline)	Insulation Core R-value[1]	Typical Panel Thickness		Rated R-value of Continuous Insulation[5] None	R-2	R-4	R-5
				A	B	C	D
OSB	R-14	4.5 in	1	0.061	0.055	0.049	0.047
Single 2x	R-14	4.5 in	2	0.071	0.061	0.054	0.051
Double 2x	R-14	4.5 in	3	0.077	0.065	0.057	0.054
I-joist	R-14	4.5 in	4	0.070	0.060	0.053	0.051
OSB	R-18[2]	4.5 in	5	0.053	0.045	0.041	0.039
Single 2x	R-18[2]	4.5 in	6	0.061	0.052	0.047	0.045
Double 2x	R-18[2]	4.5 in	7	0.066	0.056	0.050	0.048
I-joist	R-18[2]	4.5 in	8	0.059	0.051	0.046	0.044
OSB	R-22	6.5 in	9	0.041	0.038	0.036	0.035
Single 2x	R-22	6.5 in	10	0.050	0.044	0.040	0.039
Double 2x	R-22	6.5 in	11	0.054	0.048	0.043	0.041
I-joist	R-22	6.5 in	12	0.048	0.043	0.039	0.038
OSB	R-28	8.25 in	13	0.032	0.030	0.029	0.028
Single 2x	R-28	8.25 in	14	0.039	0.036	0.033	0.032
Double 2x	R-28	8.25 in	15	0.043	0.039	0.035	0.034
I-joist	R-28	8.25 in	16	0.037	0.034	0.032	0.031

Benefits:

- High insulation, low thermal bridging
- Factory fabricated
- Lower labor costs
- Seismic durability

Challenges:

- Uncommon practice
- Material costs

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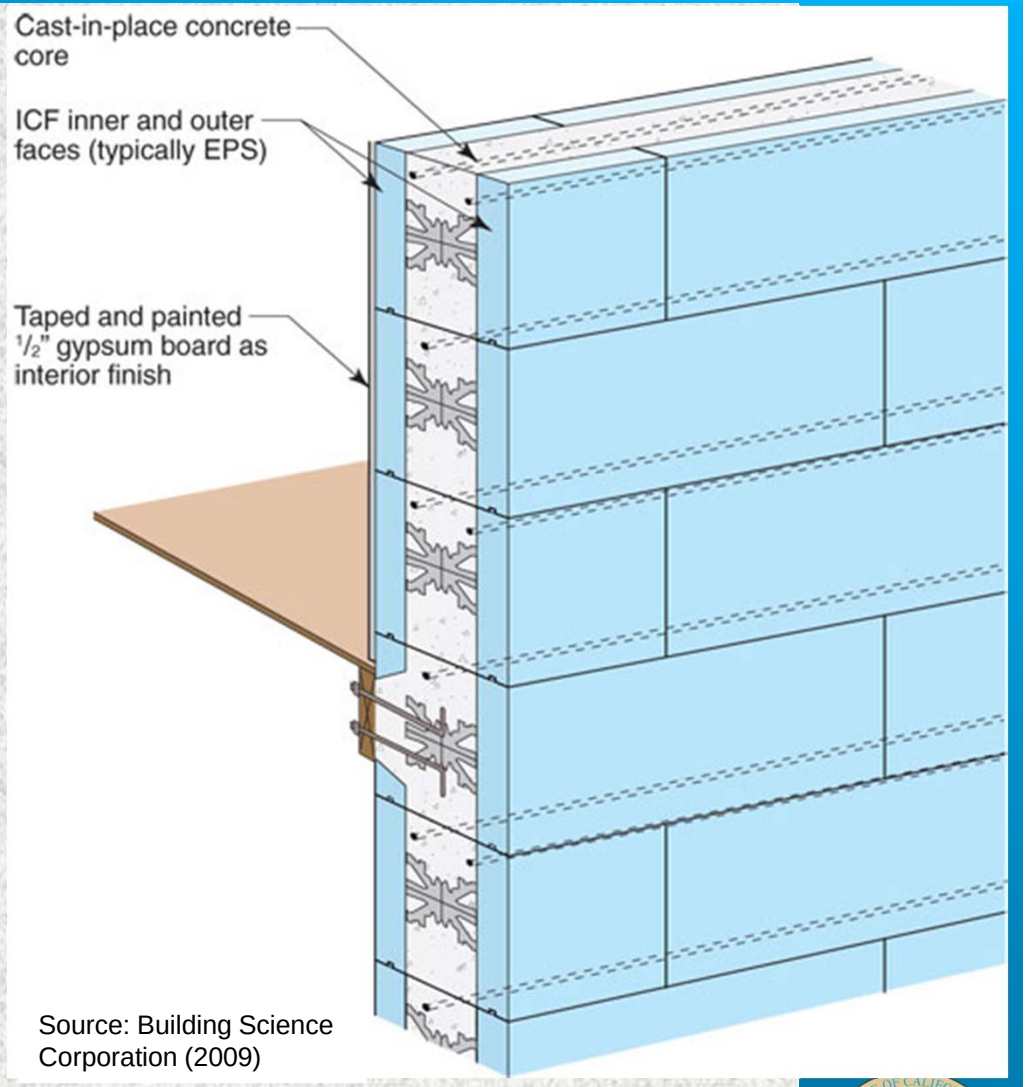
Compliance Option - ICFs

Case Description	Wall U-factor
4" flat core 2" EPS each side	0.058
8" flat core 2.5" EPS each side	0.046
8" flat core 2.5" XPS each side	0.036
10" flat core 4.5" polyurethane each side	0.022



Source: Building Science Corporation (2009)

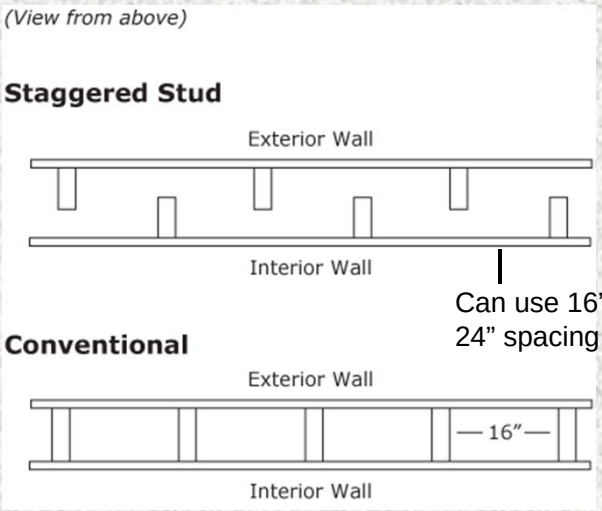
Benefits:

- High insulation, low thermal bridging
- Factory fabricated
- Lower labor costs
- Seismic durability

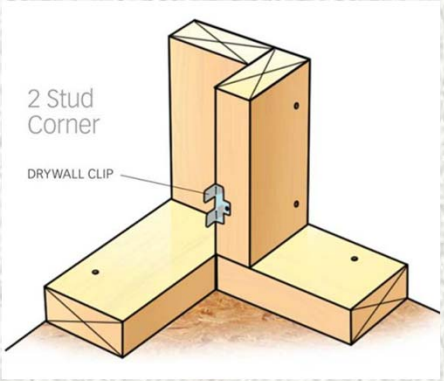
Challenges:

- Uncommon practice
- Material costs
- Need additional equipment for installation (crane)

Staggered Studs



Source: Leap Frog House (2008)



Benefits:

- Can use 2x4" studs for 6" cavity
- Greater volume of cavity insulation
- Reduce thermal bridging (reduce framing factor)

Challenges:

- Learning curve / Increases labor hours
- Planning for wall penetrations

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Advanced Framing

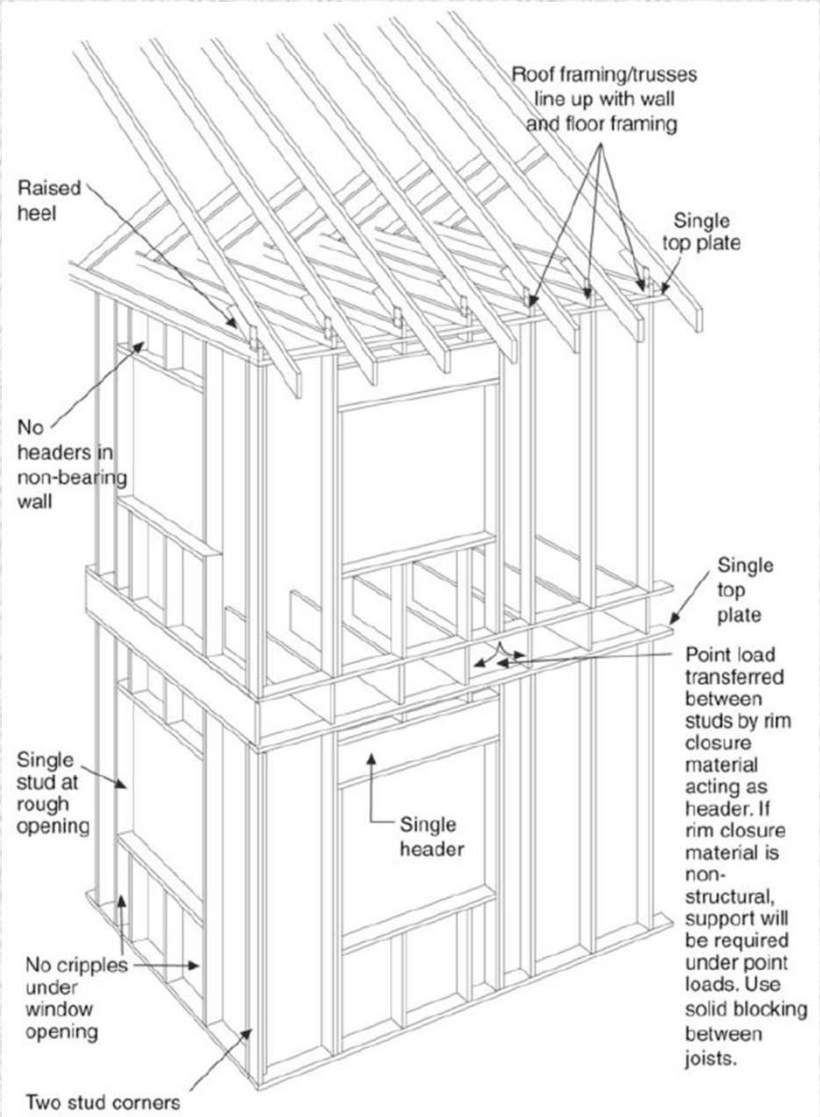

Figure 2: Advanced framing

Source: Building Science Corporation (2010)

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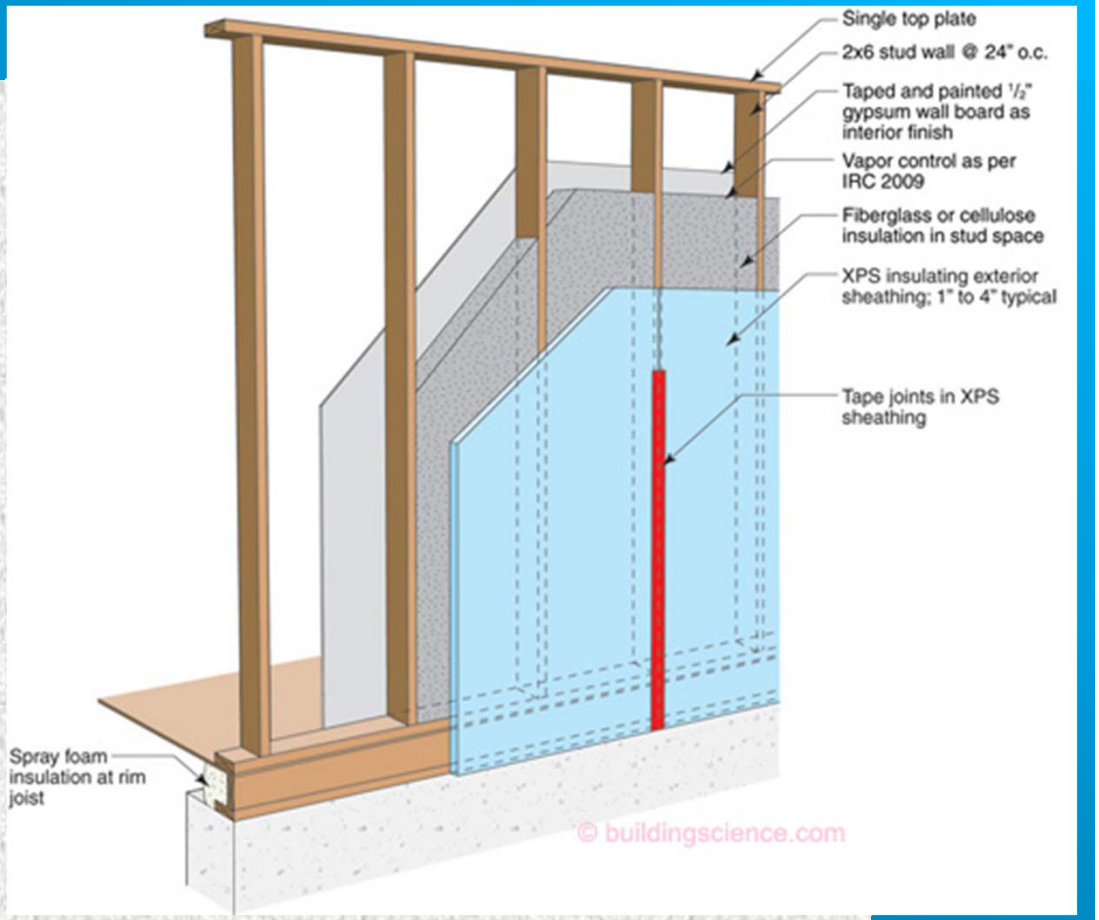
Advanced Framing

Benefits:

- Reduces material costs
- Reduces labor (after learning curve)
- Reduces thermal bridging (lower framing factor)
- Dry wall clips can reduce drywall cracking



Source: Building Science Corporation (2003)

Challenges:

- Learning curve
- Additional upfront planning more important to reap full benefits

Additional Builder Resources:

- APA Construction Guide: Advanced Framing M400

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Questions?

Comments by Email

The Energy Commission encourages comments by email.

- Comments should be in a downloadable, searchable format such as Microsoft Word or Adobe Acrobat
- Include your name and any organization name
- Include the docket number 14-BSTD-01 and indicate *2016 Building Standards Update* in the subject line

Send comments to:
docket@energy.ca.gov